

Remarks

Applicants and their attorney gratefully acknowledge that the Office Action mailed November 12 was not made a final action.

Claims 1, 3-8, 10-12, 14, 15, 19-21, 26-29, 48, 49, 54, 55, 57, 61, 63-76, 80-82, 84, and 88 are pending in this application.

Due to a restriction requirement the claims of this application are viewed as limited to species in which both the hydride and hydroxide include lithium cations.

Claims 6 and 71 have been withdrawn from consideration.

Amendments to the Claims

Claims 6 and 71 are canceled.

Independent claim 1 has been amended to recite a method for producing hydrogen upon a demand for use in a hydrogen consuming application. Paragraphs 0001-0009, and 0062, for example, of the original application describe the need for temporary storage of hydrogen, and its release upon demand, particularly for mobile vehicle applications.

In the method of independent claim 1, a mixture of particles of a hydride and of a hydroxide is prepared for the release of hydrogen on a demand. When hydrogen is demanded, a first portion of the hydride particles in the mixture are reacted with water. This preliminary reaction produces heat in an amount to initiate a further reaction (the second reaction) between a second portion of the particles of the hydride and particles of the hydroxide (all in the particle mixture). Thus, the heat from the first reaction of hydride particles and water is transferred to the other hydride particles and the hydroxide particles in the same mixture for initiation of the second reaction. The preparation and use of the particle mixture is described, for example, in paragraphs 0063 and 0082 of the specification. The use of the reaction of water with a portion of the hydride particles to initiate a second reaction between hydride particles and hydroxide particles is described, for example, in paragraphs 0007, 0008, 0052, and 0081 of the original specification.

Independent method claim 1 further requires that the portions of hydride particles in the starting mixture react substantially completely with the water and hydroxide particles to form hydrogen and an oxide as described in paragraph 0084. The goal of the initiation reaction, the second reaction, and the proportions of hydride and hydroxide in the original mixture is to maximize the release of hydrogen from the initial mixture of particles.

Independent claim 67 is also a method claim and has been amended similarly to the amendments to claim 1. The amendments to claim 67 are likewise supported by the specification.

Independent claim 72 recites a hydrogen storage composition, a different embodiment of the invention. It has also been amended to state that its hydrogenated state is for production of hydrogen on demand, and that its dehydrogenated state reflects substantially complete release of hydrogen and a residue of an oxide. Reactions of a hydride with a hydrated hydroxide are illustrated, for example, in paragraphs 0095 and 0096 of the specification. In these reactions approximately three moles of a hydride are reacted with a mole of hydrated hydroxide in a hydrogenated mixture to produce three moles of hydrogen gas and two moles of an oxide.

No new matter has been introduced into any claim by these amendments.

The Claim Rejections under 35 U.S.C. 102(b) and 35 U.S.C. 103(a)

Claims 1, 3-5, 7, 8, 10-12, 14, 15, 19-21, 26-29, 54-55, 57, 63, 67-70, 72-76, 80-82, 84 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Machin et al. (“Kinetics of the Reaction of Water Vapour with Crystalline Lithium Hydride”).

It is respectfully requested that each of these rejections be reconsidered and withdrawn in view of the amendments to independent claims 1, 67, and 72 and the arguments for allowance of these claims and their dependent claims.

Claims 48, 49, 61, 64-66, and 88 are rejected under 35 U.S.C. 103(a) as being unpatentable over Machin et al. (“Kinetics of the Reaction of Water Vapour with Crystalline Lithium Hydride”) in view of Amendola et al. (US 2004/0033194).

Again, it is respectfully requested that each of these rejections be reconsidered and withdrawn in view of the amendments to independent claims 1, 67, and 72 and the arguments for allowance of these independent claims and their dependent claims.

Reasons for the Allowance of all Rejected Claims.

The Claimed Invention

The Examiner's continuing rejection of applicants' claims is based on his conclusion that the earlier claims, broadly construed, failed to distinguish from the Machin paper and the Amendola published application. It is respectfully submitted that independent claims 1, 67, and 72, as now amended, do distinguish from any combination of these references. And their respective dependent claims are also patentable.

Each of applicants' independent claims 1 and 67 requires the preparation of a mixture of particles of a hydride and a hydroxide for release of hydrogen upon a demand for the use of hydrogen for use in a hydrogen consuming application. The proportions of hydride particles and hydroxide particles in the mixture are such that upon the completion of the steps of each method, the hydride and hydroxide have been substantially fully used in the production of hydrogen and an oxide remains.

Upon a demand for hydrogen, water is reacted with a portion of the hydride particles to produce heat that used in the particle mixture to initiate a reaction between the remaining hydride particles and the hydroxide particles. The initiation reaction involving water takes place in the prepared mixture of particles and the second reaction takes place in the prepared particle mixture.

Further with respect to independent claim 1, water may be added to the first portion of the hydride as recited in original dependent claim 7. And, as recited in original dependent claim 8, the amount of heat generated is greater than or equal to an activation energy of the hydride-hydroxide reaction. In other embodiments of the claim 1 method, some or all of the water may be provided by a hydrated hydroxide in the particle mixture as recited variously in dependent claims 19-21, 54, 55, 57, 61, and 63-66.

Independent claim 72 recites a hydrogen storage composition having a hydrogenated state and a dehydrogenated state. The hydrogenated state comprises a mixture of a

hydride and a hydrated hydroxide in which the quantity of hydride is sufficient to react with the water content and the hydroxide content of the hydrated hydroxide to produce hydrogen gas and an oxide. In the dehydrogenated state the composition comprises the oxide residue of the hydrogen gas releasing reaction. As stated above in this paper, reactions of a hydride with a hydrated hydroxide are illustrated, for example, in paragraphs 0095 and 0096 of the specification. In these reactions approximately three moles of a hydride in a mixture are reacted with a mole of hydrated hydroxide in the mixture to produce three moles of hydrogen gas and two moles of an oxide.

Machin and Amendola

The principal basis of the Examiner's rejections of applicants' independent claims 1, 67, and 72 is Machin's paper. Amendola is combined with Machin to include LiBH_4 in the totally unrelated teachings of Machin's paper.

The Machin paper describes the preparation of particles of pure LiH and the gradual addition of water to the LiH . In various experiments, different reaction products are formed and found with the LiH particles. These various reaction products, obtained in different experiments, are identified. Machin accounts for their formation by presenting chemical equations. But the thrust of Machin's work is to obtain kinetic data and reaction parameters for products resulting from the introduction of water vapor into a mass of LiH particles.

Neither the Machin et al paper nor any combination of Machin with the Amendola et al application anticipate or suggest methods comprising an initiation reaction and a second reaction for producing hydrogen from a prepared mixture of hydride particles and hydroxide particles using water to initiate a hydrogen release reaction. Machin's equations do not anticipate any of claims 1, 67, or 72. Neither Machin nor Amendola can be said to disclose the preparation of an initial mixture of particles of a hydride and particles of a hydroxide composed so as to produce hydrogen on demand and to leave a residue of an oxide. Neither Machin nor Amendola can be said to contemplate reacting water with a portion of the hydride particles in the mixture to produce heat and to use the heat to initiate a hydrogen producing reaction between other hydride particles with hydroxide particles in the same mixture and to leave a residue of an oxide.

Amended independent claims 1 and 67 recite methods that are not anticipated by the Machin disclosure and are not made obvious by Machin or any combination of Machin with Amendola. The rejections of method claims 1 and 67 and their remaining dependent claims should be dropped.

Independent claim 72 and its dependent claims are rejected as anticipated by or obvious in view of the Machin publication. But Machin does not anticipate or suggest forming a starting particulate mixture of LiH and LiOH·H₂O that is to be fully reacted to form hydrogen and lithium oxide. The rejections of claim 72 and its dependent claims should also be dropped.

It is respectfully requested that the rejections of the claims remaining in this application be reconsidered and withdrawn. It is believed that claims 1, 3-8, 10-12, 14, 15, 19-21, 26-29, 48, 49, 54, 55, 57, 61, 63-76, 80-82, 84, and 88 are in condition to be allowed and the case passed to issue.

The Examiner's patience and attention with respect to this complex application is appreciated. If there are any remaining matters that could be resolved by a telephone discussion, the Examiner is invited to call applicants' attorney at 248 786-0169.

Respectfully Submitted,

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